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EVALUATION AND MODERNIZATION OF THE SCOTT VALLEY IRRIGATION DISTRICT

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ABSTRACT

The Scott Valley Irrigation District (SVID), located in Etna, California, is a small water district that serves 25 users and runs approximately 14 miles. The district was established in the 1920's, and few modifications have happened since then. The district approached the Natural Resource and Conservation Service (NRCS) about possible improvements to the system and how do go about making decisions and implement improvements. As an outreach project the NRCS decided to pursue the evaluation and modernization plan.

The project was done in multiple phases from research, evaluation, surveying and design portions. This report will discuss the current state of the canal and structures, as well as provide detailed research on modernization options for both operations and structures.

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INTRODUCTION

Background

The Scott Valley Irrigation District, known as the SVID for the remainder of this report, is a legal special district located in Scott Valley, California. It runs approximately fourteen miles along the eastside of the Scott Valley, from near the town of Etna to a mile south of Fort Jones. The district begins by diverting their water right from the Scott River, a main tributary to the Klamath River. The water right varies depending on how much water is available in the Scott River because a certain percentage of the flow, measured in Cubic Feet per Second, needs to be maintained for the threatened salmon and steelhead fish populations. The maximum amount of flow going through the district is 9 Cubic Feet per Second during the peak river flow during the irrigation season. It serves 25 landowners and approximately 3000 acres along the ditch. The ditch has been in place since the early 1920's, and a majority of the original operations and structures are still in place today. The board of the SVID consists of a Director and two Board Members, elected by the membership, which is the sole operator of each of the 25 landowners along the canal. Aside from the three board members there are two part time employees hired; a Ditch Manager, and a Secretary/ Treasurer. There are monthly meetings that are open to the entirety of the district, however; they are scarcely attended by the membership. These meetings are held to discuss any questions or concerns pertaining to any aspect of the district. A map showing the run of the district is shown in Appendix B at the end of this report.

Most of the landowners who own property along the ditch line are members of the district, however; there are some landowners along the canal that have chosen to not utilize the service any longer for various reasons. Users are charged for the water by the amount of irrigated acres that are owned below the canal. Water is delivered in a rotation schedule for a specific duration; the owner gets an hour of water for every 25 acres of property within the ditch. Only one irrigator will receive water at a time, and the rotation begins again every 12 days. The rotation is rigid; if a user is scheduled to receive water they will, regardless of if they want it. Sometimes this can cause issues, because it is the district policy that the water delivered must be used to irrigate and cannot be stored. If a user does not need the water, they are required to feed the water back into the river via way of an irrigation ditch or pipeline. The users along the canal all utilize flood irrigation, so the unpressurized flow of the systems is acceptable.

Many of the structures and turnouts in the canal are in need of modernizations, some of which are still original structures. In 2006, a new diversion was installed at the head of the canal in the Scott River. The new diversion was designed and constructed by the Natural Resource Conservation Service and the local Resource Conservation Service. This structure has a check structure in the river to control the upstream water lever, which

then controls the flow into the ditch. Other than this, there are no check structures in the canal to control either upstream or downstream water level.

There is only one flow-measuring device along the length of the canal. It is approximately 50 yards from the diversion at the Scott River. It is a Parshall flume, which works by creating critical flow so a flow rate can be specified by the depth of the water at a specific point in the flume. In a Parshall flume this specified point is one third of the way into the constricted throat. This flume is four feet wide. A photo of the river diversion is shown in Figure 1 below.

Figure 1: Diversin from the Scott River into the Scott Valley Irrigation District

Other than this structure, there are few check structures along the canal and the turnouts are managed and maintained by the landowners; most of these turnouts are flashboards. However, only the district manager can adjust, open or close the turnouts. The manager, Mr. Stan Loudin, has been the district manager for 38 years, and knows how much to adjust each turnout depending on the amount of flow that is in the canal.

Justification

In recent years, there has been an emphasis on the modernization of irrigation districts and irrigation projects throughout the world. The purpose of these modernizations is to

improve the service to the farmer while still improving economics, labor and environmental impacts. The SVID users, directors and employees see a need for the modernization of the district and are open to various ideas.

There are several ways to modernize an irrigation project; these ways will be discussed extensively in the literature review. It is important to look at the method of delivery, how the users are charged, the structures being utilized, the labor methods as well as the irrigation methods of the users when discussing modernization. Little changes have been made to the district since it's establishment in the early 1900's. The landowners do the changes that have been made when they see the need to update their existing infrastructure. It is imperative to have uniformity throughout the district to improve the labor constraints, keep the irrigators content, and to spread errors equally throughout the system. Modernization is a costly and a very extensive process, however; being that there are very few check structures, only one flow measurement location, and the charging method is outdated, Scott Valley Irrigation District is more then eager to begin the modernization process.

Objectives

The main objective of this evaluation and modernization is to improve the operations of the district as a whole. This means finding ways to make the district operate more efficiently economically, labor friendly, environmentally conscious, and provide sustainable options, all the while understanding this is a service to the farmer. These objectives will be completed through a variety of processes including research, development, surveying, design and discussion. Modernization is a very extensive project that can take multiple years before conclusive decisions are made and construction and modernization can begin. However, the long process is more than worth the effort once the benefits are made. Because of the sizeable scope of the project, this study and report focus's mainly on the modernization of turnouts and will touch on some operational efforts that can be improved.

This project will consist of multiple stages. The first will be to research of various aspects of an irrigation district, which is shown later in this report. Then the ditch will be analyzed, which will include; walking the span of the canal, performing flow measurements, taking GPS location points of turnouts and other structures, surveying key cross sections along the canal, and interviewing multiple users as well as the board to determine issues. The next step of the project will be to analyze the findings and create a design for a standard check structure with excellent upstream level control to ensure equity at the turnouts. The final stage of the project will be to propose the analysis and designs to the Director and the Board and provide a detailed report to all interested parties. This report will describe in detail the steps taken and decisions made throughout

the entirety of the project. It is important to remember the main goal of this project; to improve the service to the users and growers.

LITERATURE REVIEW

Irrigation Districts are extremely common on the west coast of the United States, and especially in California. Many of these districts are newer or have been modernized, unlike the Scott Valley Irrigation District. This literature review will go over common district operations as well as common district structures, including flow-measuring devices. After research is completed, the project can then move forward and decisions can be made on the finial design and modernization proposal to the district and the Board.

Water delivery systems are extremely important to agriculture. The management and selection of water delivery systems are important to choose carefully because each system is different and it is imperative to consider the social and agronomic aspects (Burt and Plusquellec 1989). According to Dr. Charles Burt and Herve Plusquellec (1989), "the function of irrigation conveyance systems is to provide water in a timely and reliable manner so that the water may be efficiently used for crop production." When looking into what the Scott Valley Irrigation District to change or modify, it is important to consider the primary justifications for improving the current canal system. These justifications are shown in as follows from *Water Delivery Control* (Burt and Plusquellec 1989):

1. "Assure a reliable water supply to farmers."
2. "Assure a flexible water supply to farmers."
3. "Reduce restrictions on the capability of the farmer to attain high on-farm irrigation efficiencies, through achieving (1) and (2) above."
4. "Eliminate social conflict, which always occurs if the water supply is unreliable."

There are several other justifications that may be needed to ensure the primary ones above are met. These may include; improved safety, ease of operation, reduction in construction and operating costs, and increasing the system capacity (Burt and Plusquellec 1989).

District Operations

There are three types of irrigation scheduling when in comes to irrigation canals. These include; a demand schedule, and arranged schedule, or a rotation schedule (Burt and Plusquellec 1989). All of which are used throughout California at different water districts or water delivery services because of different purposes. They are mainly decided based on three flexibility factors; the rate, the frequency, and the duration of the system (Burt and Plusquellec 1989). Another factor that is an area of focus is the reliability of the system as well as the on farm requirements. All of these will be further outlined in this section of the report. All of these operation methods have specific requirements needed from the district entities and it is important to know what the district can handle before it adjusts the operations without modernizations or changes to the current system.

Flexibility Factors

There are three flexibility factors, as listed above, and they include the rate, the frequency and the duration (Burt and Plusquellec 1989). The rate refers to the flow rate that the user receives during the duration of their delivery (Burt and Plusquellec 1989). The frequency of the delivery is just that; how often the irrigator receives their allotted amount of water (Burt and Plusquellec 1989). The duration of the delivery is the amount of time that the user receives their specified rate (Burt and Plusquellec 1989). These factors are important to understand to be able to ensure that correct district operations are followed, and are best for the user.

Demand Schedule

The demand schedule offers the most flexibility to the users utilizing the water delivery system (Burt and Plusquellec 1989). These types of systems typically are not found in agricultural applications, but mainly in municipal systems (Burt and Plusquellec 1989). A user on a demand schedule can use the water whenever they want, which shows flexibility in frequency, and can use a small or high flow rate typically up to a certain cap, which shows flexibility in the rate (Burt and Plusquellec 1989). The water can also be used for as long as the user wants, which is flexibility in the duration of the use (Burt and Plusquellec 1989). These types of systems require little contact between the supplier and the user; however, the supplier needs to ensure that there is enough water so the neighbors will not be affected if a user is using water (Burt and Plusquellec 1989).

Arranged Schedule

An arranged schedule requires a large amount of communication between the irrigator and the water supplier (Burt and Plusquellec 1989). This system necessitates the user to specify a specific rate and duration of a water delivery in advance, which is typically 24-48 hours in California (Burt and Plusquellec 1989). The frequency of the water delivery varies depending on when the user requests the water. This type of a schedule offers medium flexibility to the users, and if the canal is satisfactory in structures it can provide a satisfactory service (Burt and Plusquellec 1989). Some arranged systems require that the user opens their turnout to receive their requested water, while others have an employee, commonly referred to as a "ditch rider," who open and close the turnout (Burt and Plusquellec 1989). However, if upstream level controls are used, which they are quite frequently, the users on the end of the ditch may not be able to receive their specified rate or duration (Burt and Plusquellec 1989). This is commonly referred to as the tail-ender problem (Burt and Plusquellec 1989).

Rotation Schedule

The rotation schedule offers users with the least amount of flexibility when compared to on demand and arranged schedule systems (Burt and Plusquellec 1989). A rotation

schedule ensures that the user will receive their allotted rate for an allotted duration at a specified frequency (Burt and Plusquellec 1989). This means that the user will know how much, how long, and when they will be receiving their delivery (Burt and Plusquellec 1989). In this type of a schedule flow meters are not needed throughout the canal (Burt and Plusquellec 1989). These systems are often put into agricultural applications by a non-agricultural consultant because they seem to provide equal amounts of water to each user (Burt and Plusquellec 1989). They also require little to no communication between the user and supplier; however, these systems are usually poorly designed and have serious control problems (Burt and Plusquellec 1989). These systems can cause a waste of water when delivered during non-beneficial time, which will decrease on-farm efficiency and it is not economical (Burt and Plusquellec 1989).

Reliability

The reliability of a water delivery system is extremely important to irrigators. According to Burt and Plusquellec (1989) there is one basic truth, which needs to be clearly understood: "water is the economic blood of the farmers. If it is provided in an uncertain and unreliable fashion, anarchy quickly develops as individual farmers try to prevent their person economical destruction." Therefore, it is imperative for the supplier to provide a reliable service to the user; however it is also the users responsibility to ensure that their turnouts are properly functioning.

On-Farm Requirements

As stated in the pervious section, it is also the landowners responsibility to ensure that their structures are suitable for both their on farm requirements as well as the water delivery system. The type and location for each turnout, within reason, should be designed for the irrigator's needs rather than the delivery system's needs (Rogers et. al 1993). Important criteria for the design are the flow rate of the turnout, the steadiness of the incoming flow, and the convenience to farmers (Rogers et. al 1993). The requirements of the crop should be used to determine the frequency, rate and duration of the delivery service; however, this service should be flexible to ensure that the flexible to leave room for changes in crop and or the water delivery system, as well as future modernizations (Rogers et al 1993).

Canal Structures

When designing and modernizing irrigation canals, structures and turnouts are an important aspect that should be focused on. There are many aspects that should be considered when deciding what structures to install; physical, economic and social constraints must be considered (Burt and Plusquellec 1989). These factors can include terrain, soil type, power availability, amount of personnel and their willingness, type of

turnouts and measuring device, and the automation of the system (Burt and Plusquellec 1989). When controlling the canal there are options that the district can choose.

Flow Rate Control

In some applications, districts will control the flow rate throughout the canal to ensure that the turnouts get the correct rate (Burt and Plusquellec 1989). In this type of system the primary objective of each structure is to maintain a certain flow rate (Burt and Plusquellec 1989). This type of canal must have a reliable source that is fairly constant (Burt and Plusquellec 1989).

Water Level Control

Instead of controlling the water flow rate, the rise of technology has helped agriculture to find a way to control upstream or downstream water level regardless of the flow rate (Burt and Plusquellec 1989). The water level control can be used in two ways; to ensure the water level is constant regardless of flow, or to control the water level to determine the flow rate (Burt and Plusquellec 1989). The most practical control for the Scott Valley Irrigation District, because the district and canal is already in place, is the upstream water level control check structure (Burt and Plusquellec 1989). This is also because this type of canal needs to be run on a rotation schedule, which is what the SVID does.

Check structures can be manual or automatically operated (Burt and Plusquellec 1989). Designing for conventional upstream control is the cheapest option, typically, when updating or modifying a system (Burt and Plusquellec 1989). A downside of this would be it severely limits the flexibility of the system, but SVID already lacks flexibility so this would not be an issue (Burt and Plusquellec 1989). These types of systems must be closely monitored by the ditch rider and water users will not be allowed to open or close their turnout (Burt and Plusquellec 1989). There are several options that can be looked at for upstream water level control, which will be explored in the later portions of this project when designs are considered.

PROCEDURES AND METHODS

The evaluation and modernization of the Scott Valley Irrigation District is a multistep and complex project. This project required several steps in the completion of the modernization recommendations that will be going back to the Scott Valley Irrigation District Board Members. The aspects of the project included preliminary coordination and communication with the district, surveying and flow measurement, inventory, design, reporting, and recommendations. This section will outline the various steps in executing the subcategories of communication, flow measurement, inventory, surveying and design. The other aspects of the project will be discussed in later sections of the report of the entire evaluation and modernization of the Scott Valley Irrigation District.

Preliminary Coordination and Communication

When initially planning the project and what the scope would encompass, it was imperative to attend numerous meeting with both the board members and irrigation ditch users to ensure the scope of the project was fully understood. Because of the users busy schedule, meeting separate from the board meetings had to be coordinated to ensure that all users and board members, as well as employees, understood what was being done. The board members were asked how they would like to better serve their users and where they saw the problems in the district. When the users were interviewed they were asked what issues they saw with the current state of the district, what they would like to see changed, and if they were interested in the modernization. The district manager, Mr. Stan Loudin who is sometimes referred to as the ditch tender, was also interviewed and used as a reference throughout the project. Mr. Loudin was asked what management issues he was faced with as well as the problem areas of the canal.

After initial interviews the scope of the project was determined. It was determined that there would be several flow measurement locations to measure flow loss through sections of the ditch. After the flow measurements were made inventory was done to see how many turnouts and structures there are along the 14 mile canal. The flow measurement and inventory procedures are outlined in full detail below. After the inventory and flow loss measurements were made, there would be more meetings with the board and district users to see the final direction of the project. After presenting the initial findings and complete list of structures to the district it was decided to proceed with modernization designs and a plan to meet again at the conclusion of the project to report findings and recommendations to the board members, district users and district employees.

Flow Measurement

After talking to the district users and district manager Mr. Stan Loudin, it was obvious that on of their main concerns were the leaky portions of the canal. Flow loss through

seepage and poor or abandoned structures was obvious even to the untrained eye, so it was decided to do flow tests upstream and downstream of the problem areas to be able to quantify the magnitude of the loss. The exact location of the flow measurement sites, as well as detail of what the loss was attributed to, are shown on the district maps in Appendix B. These measurements were important because the question of lining the canal or leaving it earthen was a large discussion within the district. Using these flow measurements it was also possible to make recommendations about lining the canal.

The flow measurements were done using a velocity meter and the two point method. There is very specific equipment that is needed for the flow measurement testing. The equipment needed are the velocity meter, in this case a propeller meter was used, a calibrated propeller mounting device to calibrate the depths of the measurement, a measuring tape, waders, a GPS unit, a pen/pencil, paper and a clipboard. The two point method is a type of canal flow measurement that is done on a cross section of the canal. This method is only supposed to be used on canals that are two feet or shallower; however, it was the method of choice even though the canal was sometimes slightly deeper in areas. A photo of the flow measurement setup for the cross section for this project is shown in Figure 2 below for one of the leaky portions.

Figure 2: Flow measurement cross section

There are several steps when doing a flow loss test. Measurements are done on cross sections of the canal. There needs to be two measurements upstream of the point in question and two measurements downstream of the point; this is to minimize error that could have occurred while taking the velocity readings. A step by step procedure of how

to do the two point method is shown below. Refer to Figure 2 above to see a photo of how flow measurement cross section is taken.

1. Find a cross section parallel to the canal at least ten canal widths from any obstruction upstream and four canal widths from any obstruction downstream. Take a GPS location point to be able to describe precisely where the flow measurement location was.
2. Measure the width of the canal and record it, leaving the measuring tape across the canal. Then divide the canal into segments of equal width across the channel and record the width. Note the measuring tape across the width of the canal in Figure 2 shown above.
3. In the middle of the first segment record the depth using the calibrated mounting rod. This rod can be seen in Figure 2 above as well.
4. Take a velocity measurement in the middle of the first segment at 80% of the depth, being sure to take the measurement while standing downstream and pointing the velocity meter upstream. Record this velocity and then repeat in the same cross section at 20% of the depth.
5. Repeat steps 3 and 4 above for each segment in the cross section.

After the measurements are taken flow can then be calculated by averaging out the two velocities obtained for each segment. Then using the following equation, flow could be calculated for each segment of the measured cross section.

$$Q = v * A \qquad \text{(Equation 1)}$$

Where, Q = Flow Rate in CFS
v = Averaged Velocity in Ft/S, and
A = Area of Segment (Width * Depth) in Sq. Ft

After the flow for each segment is found, the flow for the entire cross section can be calculated by summing all of the segments flow rates. This method can be done by one person alone, but was done with two people for this project. It consisted of one person in the water running the velocity meter and the other on the bank of the canal recording the velocities and cross sectional areas. It is important to do a quick run through of the calculations in the field to ensure that there were no pertinent errors in the cross sectional measurement because if a measurement has to be done at a later date, every cross section must be re-measured to the fluctuating flow rate in irrigation canals. Repeat the above process for each cross section needed; the two upstream and the two downstream.

Once all of the flow measurements are made the results can be taken back to the office and analyzed. The data collected and calculations should be double checked and put into

a database of some sort. For this project Excel was used to keep the data organized as well as a double check for the calculations. A sample table of the data for one cross sectional flow measurement, after it was organized into the database is shown below in Table 1. The full database can be seen in Appendix C at the end of this report

Table 1: Flow Measurement Data Table.

Site: SVID; Black Ranch
Date/Time: 07-01-09 / 9:15am
Rod: Ashley Parry Recorder: Lorrie Bundy
Cross Section: Leaky Ditch, Upstream #2
Number of Cells: 6 Width of Cells: ~ 2 ft

Cell #	1	2	3	4	5	6
Width (ft)	1.50	2.00	2.00	2.00	2.00	2.00
Depth (ft)	0.30	1.00	1.55	2.20	2.40	1.90
Velocity (ft/s)	0.33	0.87	1.11	1.61	1.35	0.68
q (W*D*V)	0.15	1.74	3.44	7.08	6.48	2.58

∑q = Q = **21.48** **cfs**

There is one velocity for each flow segment because they were averaged in the field notes and then the average was directly input into the table created for the flow calculations. The flow for the two upstream cross sections were averaged and then compared to the averaged flow from the two downstream cross sections. These two values for flow are then compared to each other to see if there is a large difference from the flow upstream to the flow downstream. The results obtained from these tests are thoroughly discussed in the results and discussion section and the database created is shown in Appendix C.

Inventory

The inventory of the canal was a fairly simple, yet time consuming project. It was decided that inventory would be done on all of the structures and turnouts the entire span of the canal to determine the condition of each. To perform this stage of the project, the entire span of the fourteen-mile long canal was walked to ensure that no structure was missed. The tools needed for this portion of the product were a dependable camera, a portable GPS, tape measure, a note pad, paper, and pen.

A protocol was established to ensure that each structure had the same photos and ranking system. When a new structure was found, the first step in the process was to take a GPS location point to identify the structure on the map. Each structure was designated a number to be referred to at this time. The numbering system began at the most downstream end of the canal beginning with the number one. After the name designation, the next step was to take the required photos of the structure. There were a total of 5 photos taken of each specific structure; one from the upstream approach, one from the

downstream, on looking perpendicular across the canal, one perpendicular from the other side of the structure, and the last was the top view of the structure. Figure 3, below, shows a photo of a turnout structure being analyzed. The photo is taken from the turnout lateral looking towards the main canal.

Figure 3: Analyzing a turnout using protocol.

After photos were taken analysis and measurements were done on the structure. Each structure was then ranked on an objective scale of one to ten, one being the lowest and ten being the highest, based on the strength, whether or not it leaks, integrity and usefulness. The measurements, designation, photos, notes and ratings were then all put into a database when back at the office. The GPS location points were also recorded and put onto a map using GIS. This database is shown at the end of this report in Appendix D and the map of these locations is shown in Appendix B.

This step was imperative because it goes over all of the current structures in the canal. It is vital to know the extent of which modernization is needed, and this is the first step in understanding what can be fixed, modified, or taken out. The findings and decisions made after this procedure are outlined in detail in the results section of this report. An

example of a table created for the database is shown in Table 2 below, and the full compilation of the database is shown in Appendix D.

Table 2: Turnout Inventory example table

Turnout Number: 6			GPS Point: 014 & 027	
Date/Time: 7-20-09 / 10:30 am			Location: Piersall	
Number of Photo's:			Recorder: A. Parry	
Observations / Structure				
Some replacement practices were evident, the box is fairly leaky, and is located right after a double culvert.				
Dimensions:	In:	3'6" Tall 3'6" Wide 15' Deep	Out:	3'6" Tall 7'3" Wide 20" Deep
Recommendations:				
Structure looks good, but boards and tarp need to be replaced to prevent some of the leak that is occurring at that box. RANK = 6 out of 10				

Surveying

The surveying needed depended heavily on the previous stages of the project. The locations that were surveyed were chosen carefully based on the results from the previous sections. When discussing the issues present in the system with the users and district employees, they discussed concerning areas along the canal that they felt could be changed or completely redone. The flow measuring phase of the project showed the leaky portions of the canal and where changes needed to be made to ensure that water stayed in the canal long enough to get to the users. When performing the inventory, there were several structures that needed replacing and modification. These locations discussed above were the key locations along the canal that were surveyed so design could be done.

The surveying process was fairly straightforward. A laser level was used to complete all of the surveying along the canal, and a GPS was used to show the locations of the cross sectional surveys that were conducted.

To complete the survey, the first step is to place the laser on the base at a location that can be seen where all measurements for that cross-section and it needs to be perfectly level. The next step is to perform a back site to a point of known elevation that all other measurement point elevations can be calculated from. After those steps are complete, the survey of the canal cross section can begin. The important measurements to take or the top of bank on both sides, high water mark on both sides, bottom of back, and center of

canal. It is important to draw the cross section in a notebook so the distances between measurements as well as the elevation change between the points are accurately recorded for later analysis in the office for the design of new structures.

It is important to take accurate recordings of the survey because the design is completely based on the dimensions received in the survey. The main survey that will be discussed in this report is the standard cross section downstream of a turnout. A complete list and cross sections of the measurements taken are shown on a district map located in Appendix B attached. This crucial step in the modernization process should be carefully planned and executed as the designs for modernization depend solely on this step.

Design

The design portion of the modernization of the Scott Valley Irrigation District is quite large. However, for this stage and phase of the project, involved parties have decided to first focus on the upstream water level control at the various turnouts. After much discussion, it was decided that a standard device should be used to ensure uniformity among the district at each turnout. The discussion and verification as to why this aspect of the project was chosen to focus on first is shown in the results and conclusions section later in this report. This section will outline how the design was done and the various decisions and assumptions that were made in the design project.

When talking to the manager board members it was decided that the landowners where the new structures would be going in would be installing and maintaining the new modernized structures. Because of this fact, it was chosen that an Irrigation Training and Research Center (ITRC) Flap Gate would be the chosen design standard for the upstream level control at turnouts (ITRC). The ITRC Flap Gate requires little maintenance after instillation, so it will be of benefit to the users in both operations and management perspectives. A example photo of an ITRC Flap Gate is shown in Figure 4 below.

Figure 4: Example of an ITRC Flap Gate

When designing the standard ITRC Flap Gate, the Microsoft Excel Program that was developed by the ITRC was used to get the correct dimensions and sizes for the design of the water level control device. It was decided that a standard section would be as is outlined from the laser level survey completed for a standard cross section. Each location would need a standard concrete section to be constructed for the ITRC Flap Gate to be installed on. The section would be 5 feet wide and approximately 8 feet long in the direction of the flow. Once this was established, knowing that the turnouts would require approximately 28 inches of water height, the Flap Gate could then be designed. The photo, Figure 4, below shows a generic design of a flap gate.

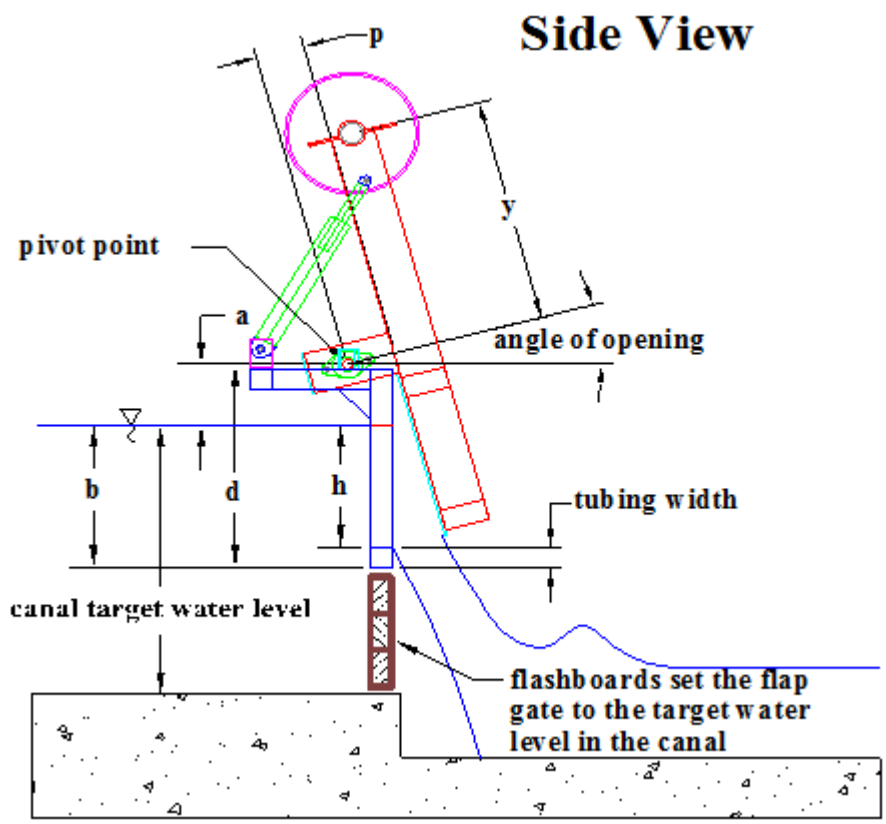

Figure 5: ITRC Flap Gate generic schematic (ITRC)

After examination of this schematic, it was decided that two 2 by 4 flashboard would be set under the flap gate to cut down on metal cost, as well as to give the operator some level of adjustment if water level needs to be changed in the canal. After these constraints were developed, the ITRC program was then used to design for the generic flap gate. The process is very iterative. The inputs are the width of the cross section as well as the 'b' value from the above, which is the desired 28 inch water level with the 8 inches of

flashboards subtracted from it. After these values are entered into the program, there are several other values that can be changed. These values range from the height to the pivot point, to the number of disks for the counterweight to the distance from the pivot point to the centroid of the counterweight. There are several design checks that need to be performed when designing a flap gate and the ITRC program does these for you. The values that can be adjusted require fine tuning to obtain the necessary design checks and to ensure proper function of each of the flap gates. A table of the designed dimensions obtained from running this program for SVID is shown below in Table 3. The entire design is shown in Appendix E at the end of the report.

Table 3: Final ITRC Flap Gate design dimensions.

Pivot height above bottom of static frame	**26.0**	inches
Lever arm length (p)	**4.50**	inches
Counterweight height (y)	**11.50**	inches
Length of tubing used for dynamic parts	**15.5**	feet **Same size tubing must be used for all dynamic parts**
Length of tubing used for static frame	**15.5**	feet **Includes both vertical and horizontal tubing selections**
Total length of tubing needed	**31.0**	feet
Weight of gate without counterweight	**206**	pounds
Weight of counterweight	**862**	pounds
Total Weight	**1068**	pounds
Max. angle of opening	**33**	degrees **Put the stop before this**
Estimated Max. Flow Rate	**25**	cubic feet / second

As shown in Table 3 above, the maximum flow rate that the flap gate can handle is 25 CFS. This is higher than the amount of water that SVID can pull from the Scott River, therefore this design is robust and will work well for the district and will help the turnouts deliver the correct head required for equity throughout the district.

RESULTS AND DISCUSSION

After thorough evaluation of the district and all of it entities, many decisions had to be made about the direction of the modernization and where to begin the process. As a scope for this project, it was decided that upstream water level structures would be designed for the turnout and recommendations for further modernization would be presented. This section will go over the findings from the preliminary studies and inventory of the district and discuss the decisions made and the design of the system.

Goals for the District

The District had specific goals in mind when they first asked for technical assistance. This section of the report is the initial and long term goals that were set forth by the district and how those goals played into the decisions made during the scope of this project. There are existing proven strategies that can be investigated, if the board desires, for short term and long term structural and administrative improvements. Before these ideas can be fleshed out, it is suggested that the Board spend time developing short term and long term goals. Many of the ideas mentioned here are taken from publically available documents and studies.

The SVID is burdened with an antiquated structure and fee schedule that may not suite the next hundred years. There are irrigation districts throughout the western US that have grappled with these same issues. Some questions that districts looking to modernize might be asking are: How do we keep our water right? How do we pay for new fees, rising maintenance costs? How do we compete with other claims on a limited water supply? How can we best assist our membership to stay economically viable?

When SVID decided to look for technical assistance, it was required of them to supply a list of the short and long term goals they were looking to fix before modernization plans proceeded further. SVID was told that these steps should be seen as steps to a discussion and a clearer focus on the future direction of the SVID for future generations. Below is the list of the goals that were seen necessary by the Scott Valley Irrigation District.

Short Term Goals

These goals were developed to be completed within a year. These goals then were used as a part of the big picture and decisions on what kind of long term goals that should be made came from the completion of many of the long term goals that were then set into place. A few of these short term goals were completed in this portion of the project, and those details will be discussed later in the report.

- Develop and distribute a questionnaire to all users and landowners along the district boundaries. This will help the board determine the modernization

direction to move in to make the land owners, and most importantly the users, happy with a more effective and efficient system.

- Find and inventory the historical documents that exist for SVID. Commit some time and effort to archiving valuable documents, maps and pictures for future generations to use. Make these documents available electronically.
- Find and update the existing Operations and Maintenance Plan. Do this in conjunction with recommendations set forth by the modernization and other improvements proposed to the district.
- Complete the inventory of the infrastructure along the entire length of the canal.
- Make an economic plan and budget for long term improvements.

Long Term Goals

The long term goals that were put into place by the district users, the district board, as well as those providing technical assistance are outlined here. While some of these were in this scope of the project and others were not, it is important to know that these goals are the direction the district wants to be heading in as a whole. The following is the list of long term goals set forth by the district and its entities.

- Cost Structures: One of the benefit/limitations of the SVID is the inexpensive cost of water. This has both positive and negative impacts on the district. There may be reasons to look at how to restructure the fees and fee schedule to allow for structural improvements, increased management which would require increased staff salary, improved system and water supply reliability and long term viability. There are economic models and guidebooks available to help restructure the fees/costs assessed by irrigation districts. A feasibility study may allow for some good suggestions regarding the cost of delivering water and doing business. This feasibility study will take place after a modernization plan is constructed.
- Canal/Structural Maintenance Plan: Analyze the existing efforts to keep up with maintenance on fourteen miles of the canal, 30+ turnouts, a large diversion/dam, and other appurtenances. Is the effort adequate? If so or if not, what is and what is not working? The main question is, how can the existing system be improved?
- Water Management Plan: Commission a study of existing management. How is the water managed now? Is it fair? Is it cost effective? Ask for some economically feasible improvement based on irrigators and Board issues and suggestions. How can the system be improved?
- Water Conservation: Perform a feasibility study; a blue-print for structural improvements that would detail the scope, strategy and timing of capital improvements. There are a lot of ideas floating around, and which one does the district want to purse? In order to receive grant money, a plan must be in place that is adopted by the SVID board and membership. As a portion of this study,

conduct a study of effective acre feet used by irrigation, by crop, by season, by user, to get a feel for the overall effectiveness.

- Revenue Enhancement: The SVID provides many benefits to the Scott Valley area as a whole and to the Eastside neighborhood specifically. These could be investigated for possible revenue sources. A cost/benefit study could be undertaken to look at these, as well as some other ideas: new users, flood control district, garden users, trails, split rates for stand by users, non-users, stock water users and small parcels, and wildlife benefits. Could a wildlife easement but put into place and be funded?
- Long Term Sustainability of the District: In order to protect the water rights and the beneficial use to Scott Valley, it may be necessary to investigate the conjunctive use of surface/groundwater, which is currently undocumented. In plain English: Prove the groundwater recharge is a beneficial use.

Modernization Options

There are many options for modernizing the current SVID system. In this report, we attempted to offer a wide variety of options for modernizing the structures, management, and the ditch itself. The options below are just recommendations on how to improve the current system and any can be pursued or disregarded as the Board and members decide.

One option that should be highly considered is the trash screens that Lynn Brown has designed to cover culverts and road crossings and rid the system of debris. They will make management and cleaning of the ditch a much simpler job. Drawings and cost estimates are already compiled for this option and can be found in Appendix E.

There are many turnouts along the ditch that need updating and up keeping due to poor infrastructure and large leaks along the ditch line. These turnouts either need to be replaced or repaired. The concrete can be repaired using Epoxy as a sealant in the cracks. The structures themselves can be replaced using Briggs pre-manufactured boxes (photos shown in Appendix C). The boards and tarps can be replaced using flashboards and foam. Cost estimates for these products can be found in Appendix F.

There are portions of the ditch where water leaks, either due to burrowing animals, alluvial fans, or leaky soils. To fix this, the SVID has been rolling the ditch using clay to seal the leaks. This method works well, but only lasts for three to five years. A more permanent fix may be more cost effective for the district. Some options include; lining the ditch with plastic liner in area's of trouble, or lining the ditch with concrete in leaky areas. The cost estimates of these alternatives are found in Appendix F.

The fee structure for the ditch is fairly antiquated. Evaluation of the structure and feasibility of applying a new one should be discussed among the Board. Some suggestions include; stand by fee's, charging by amount of water (not acreage), small fee for houses for lawns and gardens, and try to get funding for providing a wildlife buffer strip throughout Scott Valley.

Opportunities for Further Assessment

While there were many findings and useful observations this summer, the opportunity for continuing this project into the future would benefit the district even more. Not only would it benefit the district, but Ashley Parry would benefit by using this project as a senior project if it continues, and if the board and irrigators are in agreement.

The NRCS did not complete evaluations of the slope of the ditch over certain sections. Nor was there a focus in creating typical sections (i.e. bed rock, forest soils, tilled soils) that could be looked at to help diagnose problems. Next summer, those two items could be a focus for evaluation. NRCS did not have time to complete the request for technical assistance with evaluation of a new access road or a new pump station. These could be done in the summer of 2010.

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